MDE Product Development Team
FY14 October Monthly Report
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and **Ming Xue** (CAPS).

(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

Task 1: Improve turbulence guidance from NWP forecasts

- RAPv2 continued in parallel testing on WCOSS by NCEP/EMC in October and also by NCEP/NCO this month.
- An important terrain elevation fix was developed and installed in RAPv2 in early November, not changing overall results but improving RAP robustness.
- RAPv2 implementation at NCEP replacing RAPv1 is now likely to occur in early January 2014.
- RAPv2 summer 2013 configuration implementation continues to run smoothly on Jet (Boulder, RAP primary cycle) and Zeus (Fairmont WV) supercomputers and initializing experimental HRRR.
- Three real-time parallel RAP cycles (with extensive verification of each toward RAP version 3) running on Zeus NOAA research supercomputer located in Fairmont, WV to evaluate further likely enhancements to RAP data assimilation / model system for spring 2014 code freeze.
- NCEP making continued progress on NAM and NAM-nest

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- Continued work to test and evaluate HRRR run infrastructure on NCEP WCOSS machine with NCEP implementation tentatively scheduled for late Q2 FY14, following the RAPv2 implementation planned for early Jan 14.
- Testing of WRF v3.5.1 with new shallow cumulus and an updated MYNN PBL scheme and Grell-Frietas cumulus scheme in RAP real-time parallel runs
- Hourly and 15-min RTMA surface analyses running in real-time

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- RAPv2 updated physics configuration now running in both RAPv2 at GSD and in parallel cycle on WCOSS machine at NCEP [MYNN boundary-layer scheme (Olson version), 9-level PBL, updated Thompson microphysics, others]
- Upgraded Grell-Freitas deep and shallow convection scheme now in parallel testing in RAP-dev2 version at GSD, with implementation expected in RAPv3 (in ESRL in Mar 2014 and at NCEP in winter 14-15)

Task 4: Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

- Real-time, frozen RAPv2/HRRR system continued to run successfully with gridded field dissemination, real-time web display of graphics and verification of many forecast fields, including through shutdown period in October.
- Ongoing monitoring of RAPv2/HRRR system with regards to reliability (including joint reliability with Jet – Zeus failover) and forecast performance, also through shutdown in October (HRRR deemed an excepted activity).
- HRRR “failover” capability to use feed from Zeus instead of Jet during Jet downtime continued to work working.

Task 1: Improve turbulence guidance from NWP forecasts

Improving turbulence forecast quality involves efforts to improve initial conditions for the RAP and NAM (and HRRR and NAM Nest models) and to improve the models (WRF-Advanced Research WRF (ARW)-RAP and NOAA Environmental Modeling System (NEMS)- Nonhydrostatic Multi-scale Model – B (NMMB)).

Tasks will include:

- Continuing evaluation of RAPv2 toward early 2014 implementation at NCEP, incorporating changes developed in 2012 and early 2013
- Development of RAPv3 toward 2014 implementation at ESRL and subsequent implementation at NCEP
- Collaborating on developing and testing best approaches for use of hybrid/EnKF/3DVAR data assimilation within common GSI coding structure.

ESRL

Regarding the operational NCEP RAP

The operational RAP (RAPv1) ran without any technical problems, including in the post processing, during October.

Progress toward RAPv2 implementation at NCEP

Good progress was made toward the RAPv2 implementation during October despite the partial government shutdown the first half of the month.

- GSD (esp. Ming Hu) and EMC (Geoff Manikin) solved further technical issues with the NCO implementation of RAPv2, and a RAPv2 parallel cycle ran stably on the WCOSS production machine once these issues were identified and fixed in mid-October. The 30-day field test for the RAPv2 began at 12z 5 November. However, on 10 November there were two crashes of the NCO parallel RAPv2. Through the diligence and perseverance of Ming Hu, Curtis Alexander, Stan Benjamin and others at GSD working with Geoff Manikin at EMC during the last half of the holiday weekend, the crashes were traced to issues along the southern boundary where it intercepts steep terrain with numerous isolated peaks in Costa Rica, Venezuela, and Colombia. Fortunately, the primary RAPv2 cycle at GSD, running the exact same code on Zeus, also crashed, facilitating diagnosis of the cause of the crash and of candidate remedies. A solution was designed to avoid any north-south terrain gradient at the southern boundary to simply set terrain elevation at the outer row equal to the neighboring row one grid-point one in. This solution has fully solved all crashes in NCEP and ESRL RAP runs and is considered to be a robust solution.
- The RAP web page (**http://rapidrefresh.noaa.gov**) was updated with latest information on the planned RAPv2 implementation. A link to the RAPv2 Technical Implementation Notice was added there also. A webpage on RAP output grids from NCEP was updated at **http://ruc.noaa.gov/rr/RAP-NCEP-output-grids.html** .

RAPv3 data assimilation testing

Some new assimilation tests were run with RAP regarding use of mesonet observations, more detail next month.

RAPv3 model testing

- With the release of WRFv3.5.1 by NCAR on 23 September, Tanya Smirnova began work toward merging the unique RAP features at the top of the WRFv3.4.1 trunk to v3.5.1. This went fairly smoothly, and the RAP-dev2 and dev3 on Zeus have been running with this version since 21 October.
- Revision and evaluation of the Grell-Freitas convective scheme and its related shallow convection scheme was the subject of much effort in October (see task 3).
- In mid-October the Grell-Freitas scheme was introduced into RAP-dev2 and WRFv3.5.1 into dev3, whilst RAP-dev1 continued to run RAPv2. This allows us to compare WRFv3.4.1 and 3.5.1 (dev1 and dev3) and the G-F scheme with the old WRFv3.2.1 G3 deep convection scheme (dev2 and dev3). Not surprisingly, WRFv3.4.1 and 3.5.1 with identical initial conditions and very nearly identical physics give very similar results, without a clear advantage of one over the other.
- Tanya Smirnova continues to investigate changes to the RUC LSM relating to surface roughness length over snow (see Task 3).

- New precipitation-type verification is being tested with retrospective and real-time RAP and HRRR output. Now we need more real winter weather over CONUS to exercise it. Also, an NCEP W3lib routine was adapted to correctly transform RAP horizontal native grid output to the Alaska Grid 242 (Polar Stereographic) for verification purposes.

Other activities, some noted more fully under other tasks, also were undertaken:

- Retrospective testing for both RAP and HRRR of the impacts of proprietary in situ tower wind data and other special data under funding from the DOE Wind Forecast Improvement Project was concluded and a report is being written for DOE.
- Discussions with EMC are underway concerning the best procedure to ensure that proprietary wind tower and nacelle wind measurements are available to the operational RAP and NAM now that WCOSS has come online.
- Biweekly telecons between GSD and the Storm Prediction Center of NCEP continue to be very beneficial. The purpose of these telecons is to obtain feedback from SPC on RAP (RAPv2 from GSD as well as the operational v1) and GSD HRRR-primary performance, to give SPC opportunity to comment on our ongoing RAP and HRRR development work, and to inform SPC of planned Jet and Zeus computer downtimes.
- Stan Benjamin and Steve Weygandt visited FAA HQ in late October to present an overview of aviation modeling efforts in NOAA, focused on the HRRR and RAP, for Paul Fontaine and Natesh Manikoth of the FAA NextGen office.
- Stan and Steve also met that morning with AvMet to discuss applications of HRRR model data to air traffic management data by Colleen Reiche and Mike Robinson.

NCEP

All codes and scripts for version 2 of the Rapid Refresh were given to NCEP Central Operations (NCO) in October, and NCO constructed their parallel version of the system, which is now running in real time. A Technical Information Notice was composed, submitted and published – see **http://www.nws.noaa.gov/os/notification/tin13-38rap.htm** . The official evaluation period will begin during the first week of November and, barring any hitches, briefing of the NCEP Director is currently scheduled for early January with implementation to follow the following day. (Geoff Manikin)

A week-long evaluation of NCO's initial parallel for the RTMA upgrade was carried out, and the needed corrections were communicated. Inputs were provided to NCO for the Technical Implementation Notice for the RTMA upgrade – see **http://www.nws.noaa.gov/os/notification/tin13-39rtma_q4.htm**. The RTMA/URMA upgrade will occur simultaneously with the RAPv2 upgrade (see above) so that the improved RAP forecasts can be used as first guess fields over CONUS and, together with NAM nest, over Alaska. A 30-day RTMA retrospective parallel was run to test the performance of the new "smart" observation quality control. Root-mean square errors were found to improve slightly for the wind analysis. A poster on the observation quality control methodology for the RTMA was presented at the 6th WMO Symposium on Data Assimilation. A job was set up to monitor the unrestricted mesoscale analysis (URMA) versus the real-time mesoscale analysis (RTMA) data counts. (Manuel Pondeca, Steve Levine, Yuqiu Zhu)

In response to a request by the Chicago WFO, the NARRE-TL web page (see **http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/NARRE/web_site/html/icing.html**) has been upgraded to keep two days of plots so that users can see previous day's evening forecast results. An ensemble tool for member clustering has been modified to keep "time continuity" in each cluster and was delivered to NCO for its implementation into the operational SREF. (Binbin Zhou, Jun Du)

The new NAM BUFR data used for cloud analysis were examined in WCOSS. Changes in the cloud analysis for parallel NMMB were merged into GSI and are under review for committal to the SubVersion trunk. A parallel NAM using reflectivity & new cloud analysis (NAMREF) was set up in WCOSS to examine the performance when using the cloud analysis and diabatic digital filter. (Shun Liu)

The GSI used in the off-line parallel to test the new satellite bias correction scheme was upgraded to include GFS spectral IO modifications. In preparation for a significant resolution increase in the global ensemble, which is used in the NDAS parallel regional hybrid analysis, this upgrade would reduce the memory footprint of GFS spectral IO routines. In the current configuration, every MPI task allocates the entire sigma data structure even though each task/processor is only responsible for transforming a subset of the data. This is especially problematic on Linux supercomputers like WCOSS, which have less memory available per core. This update modifies the spectral IO procedures to more efficiently

read/distribute data to reduce the memory footprint. The verification statistics of the impact study on the new satellite bias correction scheme were calculated, put into a presentation, and were deemed acceptable. The scripts and initial satellite bias coefficients were prepared for implementing the new bias correction scheme in the official regional parallels. (Wan-Shu Wu)

CAPS

In October, the CAPS team mainly worked on revising a Monthly Weather Review paper documenting the results of the GSI-based EnKF-En3DVAR hybrid system for Rapid Refresh. It will be submitted soon.

Additional information on RAP-related tasks

ESRL

GSD continues to make pgrb and bgrb files from the ESRL/GSD RAP-primary (RAPv2) real-time 1-h cycle available from its FTP site for users in NWS and other labs**.**

NCEP

NCEP maintained real-time availability of SAV and AHP guidance to all vendors from the operational hourly RAP on pressure surfaces via the NWS Family of Services (FOS) data feed and via the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC&NCO)

NCEP maintained real-time availability of full resolution gridded data from the operational RAP runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/rap/prod/** and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/** in hourly directories named MT.rap_CY.00 through MT.rap_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml.** Gridded RAP and NARRE [-TL] fields are available on **NOMADS** for the CONUS domain on 13 km grid #130 and the Alaska domain on 11.25 km grid #242. RAP fields are also available for the larger North American domain on 32 km grid #221. A limited set of fields from the RAP runs (and other NCEP models) can also be viewed at **http://mag.ncep.noaa.gov** . (EMC&NCO)

Verification of RAP

ESRL's verification of the RAP is available from **http://ruc.noaa.gov/stats**. NCEP maintained its capability and provided access to routine verifications of the operational RAP analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch website: **http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html** .

Deliverables	**Delivery Schedule**
Task 1 – Improve turbulence guidance from NWP forecasts	
a. Finalize code for RAPv2 for implementation at NCEP (ESRL, NCEP) • Vigorous effort leading complete package with extensive improvements, summary at: **http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2013.pdf**	Mar 2013 **COMPLETE**
b. Complete the testing of the 40/13 km dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data (GSD, CAPS) • Initial work completed by CAPS, testing of further enhancements to system. GSD testing and inclusion in RAPv2 of hybrid system with full observational data, using GFS ensemble data. Milestones exceed.	Mar 2013 **COMPLETE**

Deliverables	Delivery Schedule
d. Report on early version of RAPv3 primary cycle at GSD with physics enhancements for initialization of the HRRR. (ESRL)	Dec 2013
e. Report on the optimal configurations for including satellite data in the ensemble hybrid system to ensure overall positive impacts of the data (NCEP, ESRL)	Dec 2013
f. Finalize RAP version to initialize experimental HRRR for 2014 real-time use toward operational HRRR (ESRL)	Mar 2014
g. Deliver progress report on development of NARRE (NCEP, ESRL)	Mar 2014
h. Deliver progress report on ensemble/hybrid data assimilation for use in NARRE (ESRL, NCEP)	Mar 2014
i. Subject to NCEP Directors' approval, upgrades to observation processing and/or quality control and/or GSI and/or NMMB systems become Operational at NCEP. (NCEP)	Mar 2014
j. Incorporate physics and dynamics improvements from the user community, GSD, and NCEP into WRF for use in the Rapid Refresh system. (NCAR-MMM)	Mar 2014

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

October work to improve convective forecasts included 1) continued work to build the HRRR system on the NCEP WCOSS computer in anticipation of the 2014 NCEP operational implementation, 2) initial testing of upgrades to the WRF model system for the 2013 warm season evaluation (pre-curser to RAPv3/HRRRv2), and 3) evaluation and refinement of the 15-min RTMA procedure.

Curtis Alexander continued his work of building the HRRR system on WCOSS and transitioning testing capability to Geoff Manikin. Curtis previous built a simple HRRR test system (no 3-km pre-forecast radar data assimilation) on WCOSS and Geoff Manikin was able to run it. This enabled system analysis personnel at NCEP to examine the run configuration to facilitate recommendations for optimizing runtime and computer usage for the HRRR model run. In October, Curtis continued his work on the WCOSS HRRR, completing most of the building of the 3-km pre-forecast hour 15-min radar assimilation package. This work will enable Geoff Manikin to run the full HRRR system, so it can be evaluated and then be transferred over to NCO for operational implementation. This implementation is scheduled for Q2 of FY14, but some delay is possible.

Late in October, Initial testing of two important upgrades to the RAP system for the 2013 warm season evaluation began using real-time parallel RAP cycles. The first is the annual upgrade to the next WRF ARW model release, in this case WRFv3.5.1. The second is an upgrade from the Grell 3D (G3) cumulus parameterization scheme to the new Grell-Freites (GF) scheme. The WRFv3.5.1 versions of the G3 and GF schemes now have an effective version of a component of a shallow cumulus scheme, not working before. This new shallow cumulus capability was enabled in part by modifications to the MYNN boundary-layer scheme by Joe Olson (GSD). Initial results from the WRF model version upgrade show small impacts as expected, with some minor improvement in some field. Testing of this model version upgrade will also be conducted within the HRRR. Additional refinement of the scheme and the associated shallow cumulus scheme are ongoing.

Patrick Hofmann continued his work to refine the 15-min RTMA analysis. Both 15-min and hourly RTMA analyses are running in real-time at GSD. The 15-min RTMA has a data cutoff of 20 minutes which means the analysis latency is ~ 30

min. Comparison of the fit to observations shows worse fit for some fields and times of day for the 15-min RTMA. Patrick has been examining the distribution of observation latencies to further optimize the tradeoff between quick delivery of the analysis and allowing sufficient time for most of the observations to arrive before initiating the analysis job. Based on this analysis, we may need to delay the beginning of the RTMA job a few more minutes to increase the number of observations making it into the analysis. Patrick has also been examining the frequency with which certain automated stations report and in related work evaluating the sensitivity of RAP forecasts to length of the data window for surface observations (and associated with this, the occurrence of multiple reports from some stations within the data window). Option for dealing with this includes reducing the length of the data window, reducing the number of observations allowed for stations with multiple observation or application of super-obbing techniques.

NCEP

NCEP EMC and NCO conducted a planning exercise of what the modeling suite might look like on the Weather and Climate Operational Supercomputing System (WCOSS) Phase 1 (2013-2015) and Phase 2 (2015-2018). The size of the latter would be enhanced by the Sandy Supplemental funds. This plan incorporated ESRL/GSD along with all other contributors to the NCEP Production suite. NWS Director Louis Uccellini was briefed 28 March. These plans call for an initial HRRR implementation on 65 nodes on Phase 1, and a HRRR Ensemble (HRRRE), combining multiple runs with configurations of both WRF-ARW and NMMB, on Phase 2. A sizable bank of computing (~700 nodes) was dedicated on Phase 2 to perform advanced data assimilation for the convection-allowing scales of the HRRRE, likely involving a 4-dimensional version of the current GSI-hybrid-EnKF.

Deliverables	**Delivery Schedule**
Task 2 – Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	
a. Report on initial tests of 3-km 15-min RTMA cloud / surface analysis for use in frontal diagnostics, CI assessment and other near-surface assessments (ESRL, NCEP) • *Good progress toward 3km RTMA and RUA surface and cloud analyses* • *Successful initial tests summarized in report:* **http://ruc.noaa.gov/pdf/GSD_RTMA_report.pdf**	Feb 2013 COMPLETE
b. Incorporate all assimilation and model changes that affect the HRRR into a frozen version of HRRR (and parent Rapid Refresh) for 2013 real-time use (ESRL) • *Extensive set of enhancements in place and running in real-time experimental GSD RAPv2 / HRRR system*	Mar 2013 **COMPLETE**
c. Provide preliminary 15-min RTMA surface analyses as experimental improved basis for frontal diagnostics and other diagnostics from surface analyses (ESRL, NCEP) **Prototype HRRR-based 15-min RTMA analysis completed with sample grids and graphics.**	Aug 2013 **COMPLETE**
d. Report on computing resource status on NCEP Central Computing System, NOAA R&D Site A and NOAA R&D Site B with regards to possible implementation of HRRR (NCEP, ESRL) See above discussion concerning ~2014 implementation and Task 4	**June 2013** **COMPLETE**
e. Complete FY13 internal assessment with revised 3-km HRRR running every hour (ESRL)	Sept 2013

Deliverables	Delivery Schedule
Assessment complete with very good results seen for 2013 HRRR in objective and subjective verification and high run reliability	**COMPLETE**
f. Provide revised 15-min RTMA surface analyses as primary basis for frontal diagnostics and other diagnostics from surface analyses for real-time use in 2014 (ESRL, NCEP)	Feb 2014
g. Finalize all changes to the HRRR for real-time use in 2014 (ESRL)	Mar 2014

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

The RAPv2 physical parameterization configuration resulting from test and evaluation of physics options during the late 2012 – early 2013 period and described in previous reports is also what is being tested now on the NCEP WCOSS computer in preparation for the RAPv2 implementation scheduled for FY2013 Q2:

- New 9-level configuration of the RUC land-surface model (RUC LSM) with fix to canopy evaporation when the MYNN surface layer is used.
- Mellor-Yamada-Nakanishi-Niino (MYNN) planetary-boundary- and surface-layer scheme (modified considerably by Joe Olson) in place of the Mellor-Yamada-Janjic (MYJ) scheme used in RAPv1.
- Continue use of the Grell G3 scheme from WRFv3.2.1.
- Continue use of the Goddard short wave and RRTM long-wave radiation schemes.
- Use WRFv3.4.1 version of the Thompson microphysics.

With the RAPv2 now in parallel testing at NCEP, focus in physics development has shifted toward upgrades for RAPv3. Ongoing and anticipated work in the near future in all aspects of the physics will result in significant changes for RAPv3. The status of this work is summarized in what follows.

- Possible replacement of RRTM long wave and Goddard shortwave radiation by the long and short wave versions of RRTMG. In addition to provision for attenuation of solar radiation by aerosol, RRTMG has a more rigorous accounting for the attenuation of solar radiation by ice and snow recently developed by Greg Thompson. Consideration may also be given to better accounting for attenuation of solar radiation by boundary-layer-driven clouds through prediction of a cloud fraction (this work leveraged from other agency funding and in collaboration with NCAR). A consideration in the decision to use RRTMG may be additional computational cost.
- Further testing of candidate LSM changes. These include 1) treatment of albedo in situations of partial snow cover, which itself must be parameterized, 2) reduction of surface roughness in areas of snow cover over scrubland and cropland (earlier testing on this was mostly done with the MYJ PBL and surface layers) 3) further consideration of the representation of snow melt in low-level warm-advection conditions typical of spring. A combination of retrospective experimentation and real-time evaluation this winter is planned.
- Further upgrades to the MYNN surface and boundary layer schemes. A primary goal of this work is to reduce the daytime warm and dry bias we see with the MYNN scheme under clear skies, particularly during the warm season. Joe Olson has introduced some minor changes to the MYNN that decrease entrainment into the daytime mixed layer from above as part of an effort to mitigate the daytime warm and dry bias in the warm season. More importantly, Joe and Georg Grell developed an improvement to the treatment of shallow cumulus clouds, which partially addresses this issue. These changes are only active when there is a mixed layer. Because this warm / dry bias is likely a result of the interplay between the land-surface scheme, the surface and boundary-layer scheme and the parameterized convection, MYNN modifications must be tested together with the deep and shallow convection parameterization.
- Possible replacement of the G3 convection scheme used in RAPv1 and RAPv2 by the Grell-Freitas deep and

shallow scheme. In mid-October Georg Grell found the source of deficient precipitation from the parameterized convection in the G-F scheme that had been plaguing the scheme since it was first tested in RAP. With this fix in place in RAP-dev2 since 22 October, this cycle is now giving results generally competitive with RAP-dev3 also running WRFv3.5.1, but using the old v3.2.1 G3 scheme currently in RAPv1 and RAPv2. Evaluation of GF in a summer retro is necessary prior to a decision as to its use in RAPv3. Also during October Joe Olson made it possible to run the shallow cumulus portion of the GF scheme as a stand-alone routine. Use of only the shallow portion of G-F will be considered for HRRR application.

- Testing of changes to the Thompson microphysics for WRFv3.5.1. We anticipate these will mainly impact higher rainfall rates and therefore may be of importance for the HRRR configuration in 2014. Evaluation in HRRR has not yet begun.
- New aerosol-aware microphysics from NCAR. Pending NCAR's preparing the code for transfer to GSD (see item a. under table of Task 3 deliverables below), test and evaluation will begin by GSD. This is a potential major change and will require careful evaluation. In preparation for this, GSD met with Greg Thompson of NCAR on 15 Nov to plan some details on this transfer. We anticipate significant testing of the aerosol-aware microphysics in 2014 toward implementation in the March 2015 ESRL versions of the RAP and HRRR.

NCEP

With the HRRR prediction model running fairly efficiently, NCEP is awaiting the remainder of the HRRR system containing initialization, post-processing and product generation components which must all fit into the allocated space and complete each run within an hour.

NCAR/RAL

CURRENT EFFORTS: -In the month of October, NCAR-RAL worked jointly with WRF developers in MMM to transfer the new aerosol-aware Thompson & Eidhammer (2013) microphysics code changes into the WRF code repository.

FUTURE EFFORTS: Once integrated into the WRF code repository, NCAR-RAL will assist NOAA-GSD to adopt/utilize the new scheme. NCAR-RAL and NOAA-GSD still need to plan and carry out a method to link aerosols/species found in WRF-RAP-Chem to simplify into those variables used by the new microphysics scheme; or, alternatively, use with built-in climatological aerosols.

PROBLEMS/ISSUES ENCOUNTERED: The integration of the aerosol-aware microphysics scheme depends on availability of NOAA-GSD and NCAR-MMM personnel and a timeline of activities has not yet been decided.

INTERFACE WITH OTHER ORGANIZATIONS:
Alison Nugent (PhD student) and Ron Smith, Yale University
David Gill and Michael Duda, NCAR-MMM

NCAR/MMM

Deliver a WRF Users' Workshop and WRF Tutorial for the User Community

NCAR (joined by Steven Peckham of GSD) gave a WRF tutorial in York, UK on October 8–11. This was part of the NCAR–NCAS (National Centre for Atmospheric Science) 2013 Workshop and Tutorial. This tutorial covered the basic WRF system and WRF-Chem. Approximately 60 people attended.

The next WRF tutorial organized by MMM will be at NCAR on January 22–31, 2014. In addition to the basic WRF tutorial, it will include a WRF/DART ensemble DA tutorial and a MET (Model Evaluation Tools) tutorial.

PLANNED EFFORTS: Tutorial scheduled for January 2014

UPDATES TO SCHEDULE: NONE

NCAR is leading the oversight of preparations of the next major release, WRF V3.6. Regular meetings of the Release Committee were conducted. The release will be in Spring 2014, and information is presented here: **http://wrf-model.org/users/release.php**.

Jimy Dudhia of NCAR/MMM worked with Greg Thompson (NCAR/RAL) as part of the WRF-Solar project. Thompson has a new aerosol representation for microphysics, and the goal is to have it interact with WRF radiation packages. This work is ongoing.

Dudhia modified the WRF diffusion option to better follow theory, based on a suggestion by Rich Rotunno (NCAR/MMM). The modification was a minor change to the coefficient for the vertical diffusion of vertical momentum, and the effect on results is small. This was committed to the WRF repository for the V3.6 release.

Dudhia worked with Jose Arias (Univ. Jaen, Spain) to correct a problem with CAM radiation used with his new diffuse and direct solar outputs that showed up in software testing. This issue was related to inconsistent zenith angles in two parts of the code. A fix was added.

Dudhia is developing a PBL mixing approach for scalars and tracers, using the WRF PBL K-coefficient profile to mix these in a new part of the PBL driver. This allows scalars and tracers to be mixed consistently with the variables mixed by any of the WRF PBL schemes. The work is almost complete.

Dudhia is developing code to make diff_opt=3 (truly horizontal diffusion) work in complex terrain. Testing for this is being done by Jim Bresch (NCAR/MMM) in a Taiwan application and Travis Wilson (UCLA) in a California application. The modifications decrease the strength of mixing when terrain becomes too steep to provide a good gradient, and they help to make the code stable. So far the mods are working for the California tests, but Bresch is still isolating problems in the Taiwan tests.

PLANNED EFFORTS: The development and incorporation of new physics and dynamics for WRF for the RAP will continue through this quarter.

UPDATES TO SCHEDULE: NONE

Deliverables	**Delivery Schedule**
Task 3 – Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	**Delivery Schedule**
a. Complete initial evaluation of aerosol-aware microphysics in RAP real-time cycling at GSD for its suitability as part of the RAPv3 prototype for 2014 NCEP implementation (NCAR-RAL, ESRL)	Delayed until Feb 2014
b. Final model physics code transfer complete to EMC for Rapid Refresh 2 upgrade change package to be implemented at NCEP by spring 2014 (ESRL, NCEP) • Freeze of model physics code for March 2013 version of RAP at ESRL allows this milestone to be met.	Mar 2013 **COMPLETE**
c. Pending NCEP computer readiness and EMC and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit WRF physics code changes as part of upgrade for Rapid Refresh v2 software to NCO (NCEP, ESRL)	**Sept 2013** **COMPLETE**
d. Transfer upgraded coupled aerosol-microphysics scheme into a test version of HRRR (NCAR-MMM, ESRL)	Dec 2013
f. Finalize microphysics changes and other physics changes to improve icing forecasts for ESRL version of RAP and HRRR for 2014 real-time use (ESRL)	Mar 2014
g. Report summary of icing probability skill measures by quarter for the year. (NCEP)	Mar 2014

Task 4: Develop convection-ATM-specific improvements for guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

Task 4 – Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL)

Current:

A new retrospective period from 15-31 May 2013 has been established to begin evaluation of model and data assimilation changes for the 2014 version of the ESRL RAP and HRRR. A control run for the retrospective period has been completed using the 2013 ESRL RAP and HRRR versions but also include an adjustment in soil temperature and moisture and a correction in the RUC land surface model to remove unrealistic surface evaporation flux in areas of precipitation that were not available during the real-time runs in early May 2013. The code for the WRF-ARW version 3.5.1 update including changes to the Thompson microphysics scheme and associated reflectivity, VIL and echo top diagnostics has been merged with the ESRL RAP and HRRR WRF-ARW code base in preparation for an upcoming retrospective run for the 15-31 May 2013 period.

Planned:
We plan to complete the transition to the new format radar reflectivity data feed for both the ESRL RAP and HRRR radar data assimilation.

Evaluation of ESRL RAP and HRRR model and data assimilation changes will be conduced using the 15-31 May 2013 retrospective period. An evaluation of the latest Thompson microphysics scheme in WRF-ARW version 3.5.1 will be conducted including testing and calibration of the associated reflectivity, VIL and echo top diagnostics.

Task 4 – Assess HRRR reliability and provide monthly reporting (ESRL)

HRRR Reliability for 0-8 Hour VIL/Echo Tops for October 2013

Jet
All runs: 88.2%
3 or more consecutive missed runs: 95.4% (most meaningful for CoSPA)
6 or more consecutive missed runs: 98.5%
8 outages of at least 3 hrs. or longer
5 outages of at least 6 hrs. or longer

Zeus
All runs: 72.0%
3 or more consecutive missed runs: 76.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 79.6%
9 outages of at least 3 hrs. or longer
5 outages of at least 6 hrs. or longer

Combined (Jet or Zeus)
All runs: 92.6%
3 or more consecutive missed runs: 96.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 98.8%
6 outages of at least 3 hrs. or longer
4 outages of at least 6 hrs. or longer

Under Task 4 – Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014

Tracy Smith continued her work with the assimilation of GOES-CI cloud-top cooling radar data within the RAP. Following her initial experiments she is conducting additional retrospective experiments to examine variation in both the heating rate and the lower threshold of cloud-top cooling for which the heating will be triggered. The first change will reduce the

heating overall while the second change will eliminate heating completely for many small lower-cooling rate areas. We hypothesize that this second change may be important for reducing the false alarm in triggered convection seen in the initial assimilation retrospective run.

Also Under Task 4 – Interact with CoSPA (or other) program partner labs and the FAA

Team (ESRL/GSD, NCAR/RAL, and MIT/LL) telecons and e-mail correspondence have and will continue to occur to discuss issues related to the HRRR reliability including scheduled outage periods during the CoSPA 2013 season. Discussion with MIT/LL continues regarding possible collaboration on convective weather avoidance polygons including the potential for feedback on the evolution of the size distribution of forecasted convective structures in the HRRR. A discussion with NCAR/RAL to resolve an infrequent problem in blending the HRRR for CoSPA due to missing forecast lead times was conducted and the problem was resolved in the HRRR post-processing at ESRL/GSD.

Deliverables	**Delivery Schedule**
Task 4 – Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA	
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL) • Code for revised echo-top / reflectivity diagnostics with revised microphysics implemented in GSD real-time HRRR.	Mar 2013 **COMPLETE**
Conduct baseline testing of the early 2013 HRRR version (ESRL) • Baseline testing of 2013 HRRR version completed as part of code preparation for freeze. Summary of skill score improvements being prepared.	Mar 2013 **COMPLETE**
Report on evaluation of new microphysics scheme and associated echo-top and reflectivity diagnostics in ESRL/GSD RAP and HRRR (ESRL) • *Preliminary evaluation completed and summarized in report:* **http://ruc.noaa.gov/pdf/GSD_reflectivity_report.pdf**	Mar 2013 **COMPLETE**
Assess HRRR reliability and provide monthly reporting (ESRL) Reliability statistics are being reported each month	*Apr 2013* **COMPLETE** *(ongoing)*
Report on evaluation of revised WRFv3.4 microphysics for RAP/HRRR for its effects on echo-top and reflectivity in ESRL RAP/HRRR (ESRL)	Mar 2014
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2014 real-time use of HRRR (ESRL)	Mar 2014
Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014 (ESRL) **Evaluation of preliminary results**	Mar 2014 **Good progress**
Report on 2014 baseline testing of the HRRR (ESRL)	Mar 2014